SAFETY SYSTEMS (WBS 1.12)

The collider personnel will be protected against Radiation Hazards, Oxygen Deficiency Hazards (ODH), and Electrical Hazards by a single "RHIC Personnel Safety System" in full compliance with regulatory requirements. Ensuring personnel safety at older accelerators meant an Access Control System designed to protect personnel from radiation hazards. Other safety hazards to be found within accelerator enclosures or support buildings were mitigated by their own independent administrative controls or engineered safety solutions, often after the initial accelerator design phase and independent of the Access Control System design. Integrating all personnel safety systems in RHIC is expected to result in a superior level of personnel safety and equipment protection, while providing greater operational efficiency. It is also intended that the Personnel Safety System have a closer interface to the fire protection elements installed as part of our conventional construction than has been the case in other accelerator construction.

i. Personnel Safety Systems (WBS 1.12.1)

Required safety systems for Oxygen Deficiency Hazards (ODH), Electrical Hazards and Radiation Hazards are integrated into a single system. The Personnel Safety System will employ fourteen small Programmable Logic Controllers (PLC) interconnected as two sets of seven peers, channels "A" and "B" in Fig. 12-1, rather than a few larger units hierarchically connected to multiple remote I/O chassis. This is done to achieve a redundancy level, for the most complex part of the system, greater than that provided by the dual level achieved by other designs.

Control Devices

Commercially available Programmable Controllers are configured so as to attain the level of redundancy necessary to achieve compliance with DOE 5480.25. A network of PLC units compensates for the complex set of failure mechanisms exhibited by individual processors as compared to designs based upon relays, much as a OP-Amp compensates for component variability with gain and feedback or a bridge is supported by its interconnecting I-beams. In order to reduce the potential for Common Cause failure events, the core PLC system will be comprised of two different brands or models of PLCs such that basic

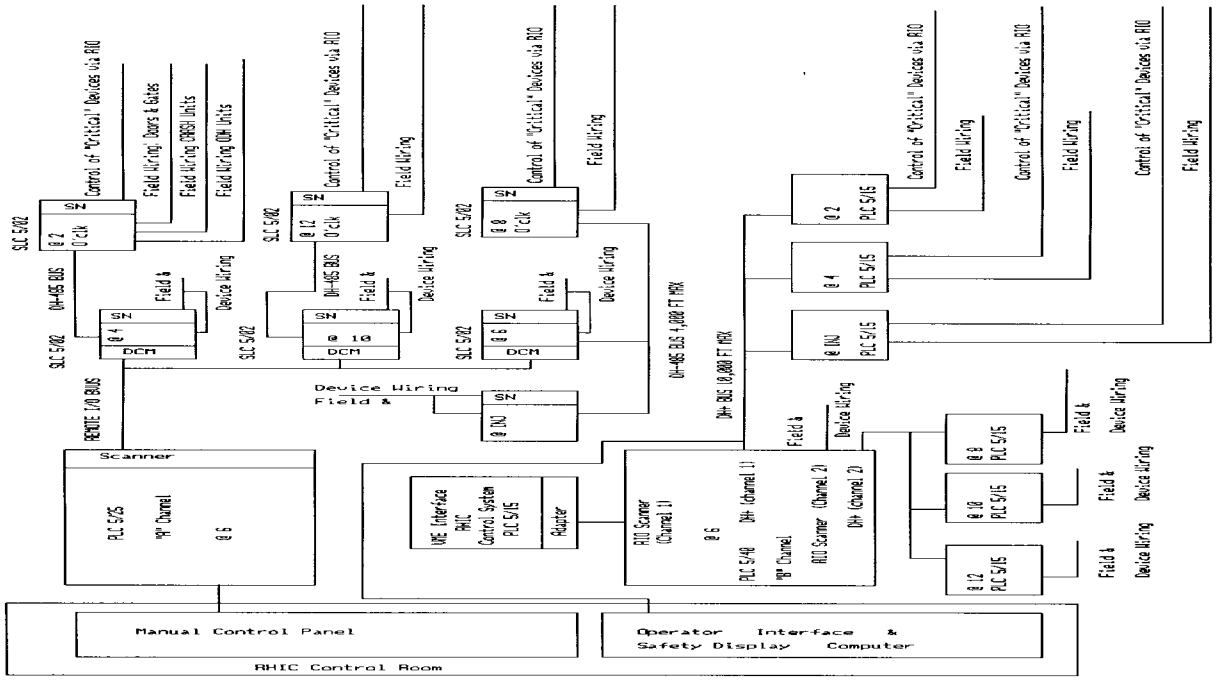

Fig. 12-1. Personnel Safety System Block Diagram.

hardware and software elements will be of different origin; each PLC has its own independent UPS and line power feed. Complications introduced by physical bus limitations result in a rather complex interconnection pattern, however, a minimum of two independent channels labeled "A" and "B" are always maintained. The "A" and "B" channels are in turn connected to one of two Command and Control processors which provide supervisory control and monitoring functions. These processors are in their turn redundantly connected to the RHIC Central Control System and to a Personnel Safety System generated Display located in the RHIC Central Control Room.

Safety Devices

An Emergency Shutdown System labeled CRASH will use "pull cord" type switches. They will be installed throughout the Collider enclosure. With minor exceptions, there will be essentially continuous coverage on both sides of the enclosure tunnel. Because of magnet locations, coverage in supported injection areas will be made on one side only. Each unit will protect 65 m (200 ft) of tunnel. The CRASH switches are not hard wired into a lockout system, but are connected in a redundant manner to a PLC in the "A" channel and to another PLC in the "B" channel. When a CRASH is called for, the Personnel Safety System will remove power from selected critical power supplies or close selected critical vacuum valves. In addition, the Beam Dump System will be activated. This dual approach is necessary because the Beam Dump system, while engineered and constructed to high standards, is not considered part of the Personnel Safety System.

The Gate system comprises thirty five (35) Gate packages and nineteen (19) Emergency Entrance and/or Exit Doors packages. Redundant interlock switches will be mounted on each of these doors. The Collider Center Entrance Gate, the "Main" Gate, will have a set of captive keys interfaced into the PLC logic such that if any key is missing from the key bank, then the Collider (and Collider injection) cannot be started. At this Main Gate will also be a standardized electronics system for information, display and access purposes; this package will include TV monitoring capability in the Main Control Room (MCR). Provision will be made to upgrade the Main Gate with a card reader based entry logging system and information display.

The Radiation Monitoring system will employ the "Chipmunk" design used at the AGS and at FERMILAB. Interlock outputs will be connected to system PLC units. Eighteen (18) units are planned for initial startup. The most likely distribution is twelve (12) units for experimental area monitoring and six (6) units for RHIC injection.

Distribution

The PLCs will be wired and programmed so that each will independently supervise the interaction area and the sextant areas nearest their physical location. In simple terms, they will provide coverage both clockwise and counterclockwise for the half-sextants nearest the location. Sensor and control elements within the tunnel enclosure will operate at 12 or 24 Vdc (Gate switches, ODH alarms, etc.). Distribution boxes located approximately every 65 m (200 ft) will be interconnected via dual multi-drop supervised cables to the PLC units, as will the wiring for Gate and Emergency Entrance/Exit Doors.

Redundant signals are carried via separate cables except when a conduit is used; safety system cables are carried either in their own tray or via conduit. Properly secured, supervised cables may be optionally employed outside the tray system.

Installation and Test

This WBS (1.12.1.4) deals with the installation of Collider and Injection components, System validation, as well as documentation and personnel training.

Personnel Safety System Support

This WBS (1.12.1.15) deals with the engineering design aspects of the safety systems. Major efforts include the following: CRASH System Design, Packaging Design, Cable Plan, Gate System design, Active System Specification and Guidance, PLC System Design, Design of back-up Power System, ODH System Design, Cable Selection, Equipment Interlock Logic, AGS Interface Design, PLC Software Coding, RHIC MCR Display and Logic Design, Radiation Monitor System, RHIC Control System Interface, Protective Equipment Selection, Design of Warning and Into Items. A special word about software. It will be generated, for the most part, in PLC ladder logic form; it is expected that there will be two general logical structures in order to minimize the possibility of a single software or logical error disabling the entire system.